

Headquarters U.S. Air Force

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Rapid Prototyping: Leapfrogging into Military Utility



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**Air Force Rapid Capabilities Office
(SAF/RCO)**

**9th Annual NDIA Science & Engineering
Technology Conference**

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Rapid Prototyping Needed

Force Protection
(e.g., IEDs)



Homeland Defense
concerns



Faster evolution of
traditional threats



- **Asymmetric threat has a very short timeline for change**
 - **COTS timeline available to threats**
 - **WWW used by threat**
- **DoD Acquisition has relatively long timeline**
 - **Limited access to COTS**
 - **Budget process is multi-year**
- **Complex systems stress definition of requirements/architecture**
 - **Requirement trade-offs delay system**
 - **Only as fast as slowest element**



SAF/RCO Rapid Prototyping

Objectives

- Rapidly develop new capabilities to counter the increasing pace of threat evolution
 - Improve acquisition process; facilitate faster transition of S&T to warfighter
 - Realistic definition of requirements & architectures for complex problems; prototype to innovate
-

Enablers

- Mindset: acceptance of 80% solution
 - Team: leadership support, warfighter involvement, “A-team” executing
 - Investments for the future: open architectures, etc.
 - Experience: practice to improve
-



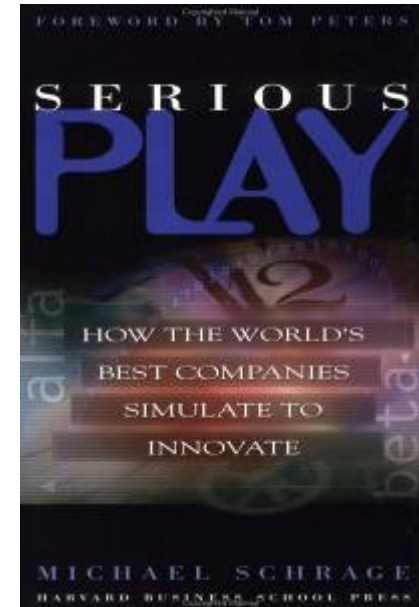
“Rapid Prototyping” in Commercial Industry



A tool for rapid design & manufacturing ...



A way to rapidly get products to market ...



A way to innovate ...

Not a new idea; approaches well established in commercial industry



Outline

- Motivation / Objectives
- ➔ ■ Air Force Rapid Capabilities Office
- Rapid Prototyping
 - Rapid capability development examples
 - Enablers to rapid development
 - Prototyping to innovate
- Summary



Air Force Rapid Capabilities Office

- **Established April 2003**
- **Mission: Expedite development and fielding of select DoD systems**
 - **Leveraging defense wide technology development efforts and existing operational capabilities**
- **Reports directly to Board of Directors**
 - **SecAF, CSAF, SAF/AQ, and USD(AT&L) chairs**
 - **Responds to Combat Air Force (CAF) and Combatant Command (COCOM) requirements**
- **Rapid Prototyping Example: National Capital Region (NCR) IADS**
 - **Enhanced Regional Situational Awareness (ERSA)**
 - **Norwegian Advanced SAM System (NASAMS)**



National Capital Region Airspace



ADIZ – Air Defense Identification Zone

FRZ – Flight-Restricted Zone

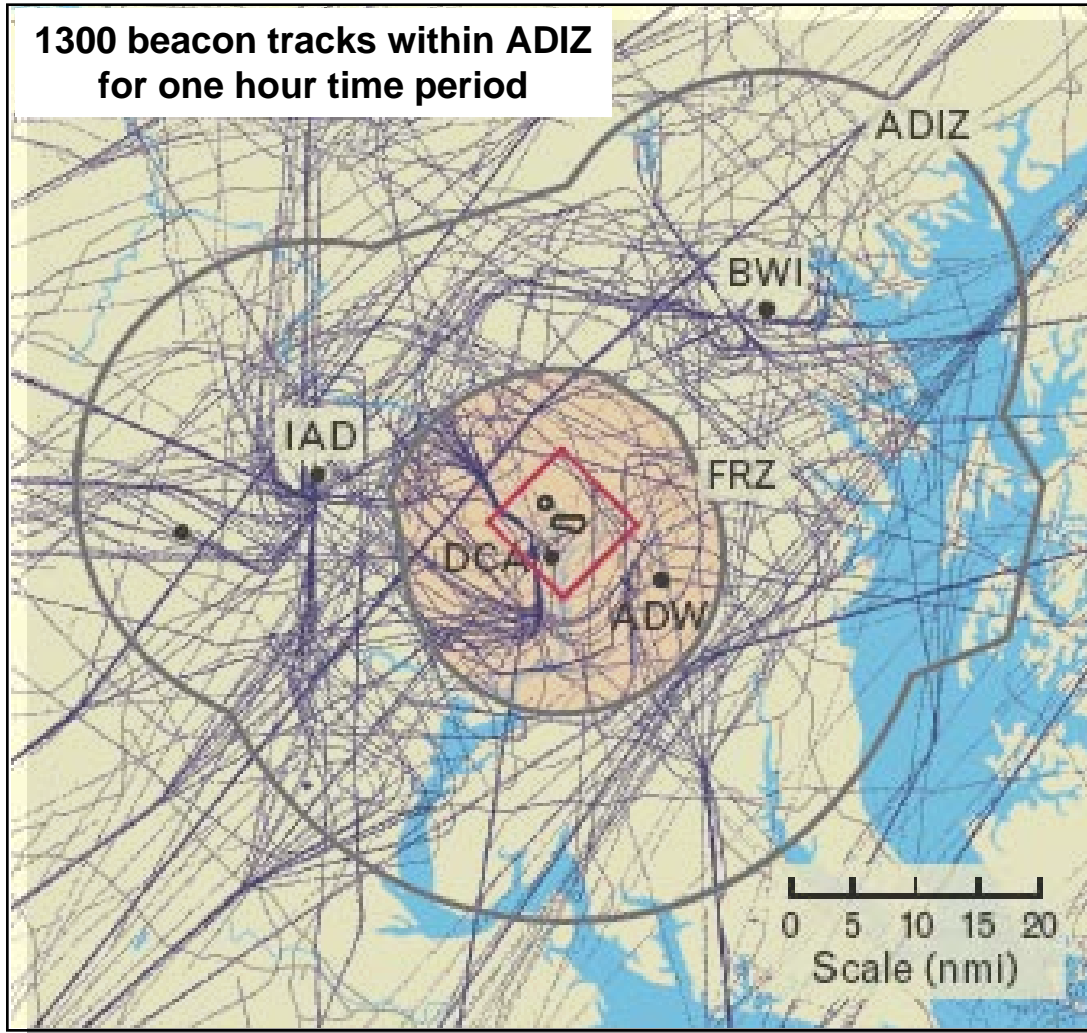
IAD – Dulles International Airport

DCA – Reagan National Airport

ADW – Andrews Air Force Base



National Capital Region Airspace



ADIZ – Air Defense Identification Zone

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IAD – Dulles International Airport

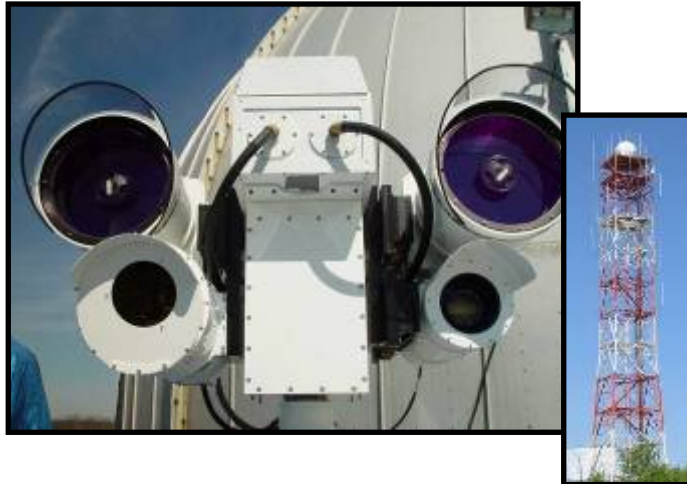
DCA – Reagan National Airport

ADW – Andrews Air Force Base



RCO Rapid Developments

Enhanced Regional Situational Awareness (ERSA)



- Integrated air defense system for National Capital Region (NCR) in 2 years
- Operational for Jan 2005 Presidential Inauguration
- Developed and Fielded
 - Tower Mounted Radars
 - Aircraft ID
 - Visual Warning

Norwegian Advanced Surface to Air Missile System (NASAMS)



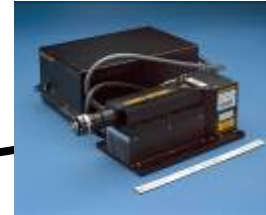
- Developed & integrated system into NCR IADS
- 9 months from Chairman JCS tasking to IOC



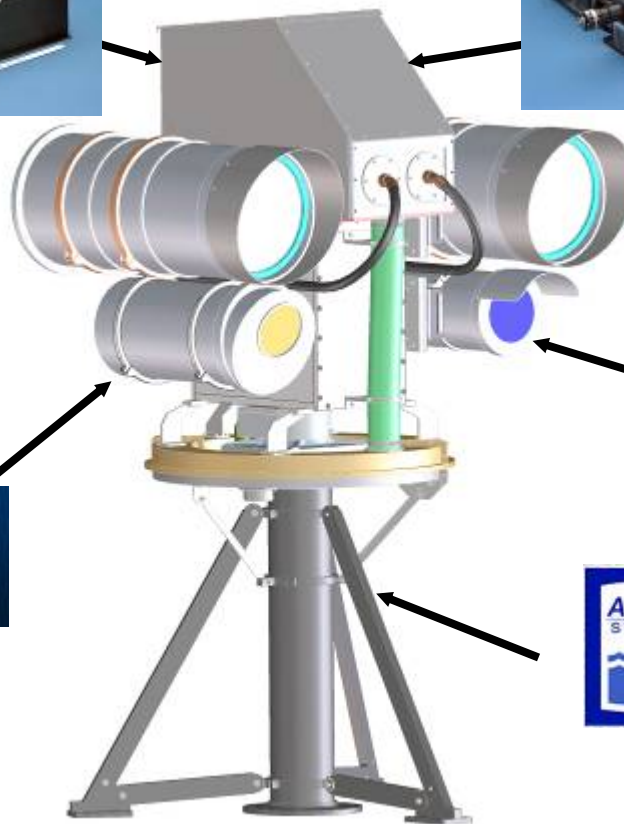
Rapid Prototyping *Visual Warning System (VWS)*



Red Light



Green Light



Visible Camera



Infrared Camera



Pedestal

Visual Warning System developed by rapidly integrating COTS to create a new capability



Visual Warning System (VWS)

- Provide visual warning to errant pilots entering NCR airspace
- Eye safe system at aperture and beyond
- Precision pointing at single aircraft
- Special Flight Advisory has been published on meaning of lights
- Operational on 21 May 2005



- Warning Sequence with translucent covers on



- Nighttime aircraft view from 3 nm, 28 Jan 05



NORAD uses the Visible Warning System

U. S. Capitol, 12 March 2008

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AIR SAFETY

Small Plane Enters Restricted Space

2nd Incident in a Week Prompts Calls to Refine Evacuation Process at Capitol

By [Mary Beth Sheridan](#)

Washington Post Staff Writer

Thursday, March 13, 2008; Page B06

A small plane penetrated restricted air space and flew within six miles of the U.S. Capitol yesterday before being intercepted without incident, officials said.

When air-traffic controllers couldn't reach the pilot by radio, military personnel on the ground aimed red and green warning lights at the cockpit, said Maj. Brian Martin, a spokesman for the [North American Aerospace Defense Command](#), or NORAD. That prompted the pilot to veer west, Martin said.

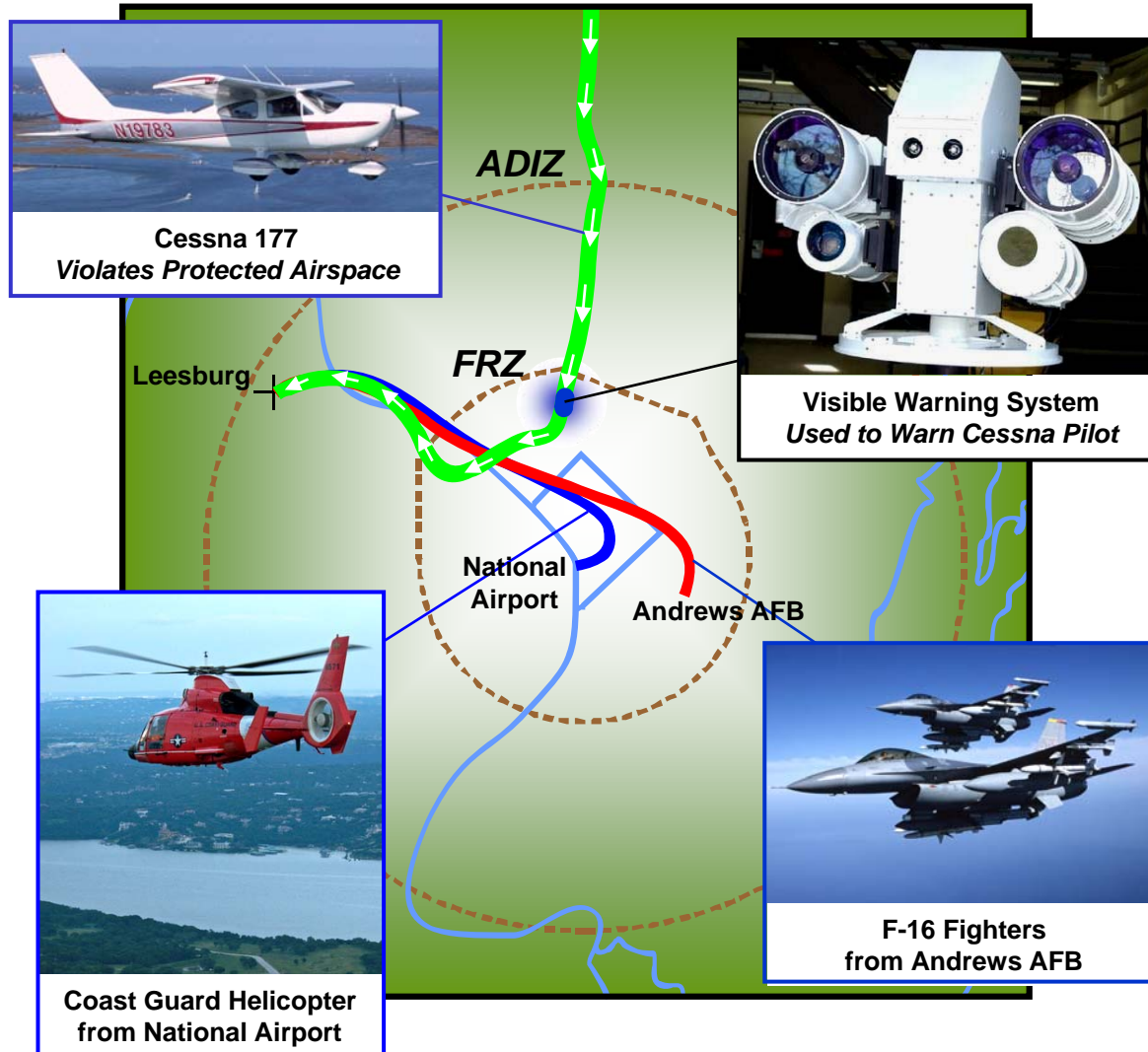
Two F-16 jets from [Andrews Air Force Base](#) and a [Coast Guard](#) helicopter escorted the plane to [Leesburg](#) airport, where the pilot was questioned by the [Secret Service](#) and the FAA, officials said. He was not considered a threat, they said.

***A NORAD spokesman
cites the use of the
Visible Warning System***



12 March 2008 Events

- A Cessna 177 crosses the Air Defense Identification Zone (ADIZ) in violation of airspace rules
- NORAD warns pilot using the Visible Warning System
- The Cessna is escorted to Leesburg Airport by F-16 interceptors

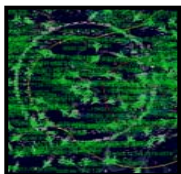




NASAMS Integration Timeline

FY04						FY05					
A	M	J	J	A	S	O	N	D	J	F	M

Chairman JCS Direction ▲



AT&L funding ▲

Fire Control Cue Developed ▲

Integration with fire control unit ▲



Fire Distribution Center

Live Fire Tests ▲ ▲

NORAD Validation and Acceptance Testing ▲ ▲

NASAMS IOC in NRC ▲



NASAMS developed, deployed and operational in nine months



Key Attributes for Rapid Fielding

- **Clear Charter with Clear Priorities**
 - **Schedule was #1; field ERSA by inauguration day 2005 (18 months)**
- **Senior DoD, Joint Staff, US Air Force, & US Army leadership buy-in**
 - **Short chain of command facilitated quick decisions**
- **Small, Focused, Empowered Team; 5 – Program Office, 7 Contractor, plus key external POC's**
 - **Experienced, solution oriented, A-team type personnel**
 - **QRC focus – Long hours, 6 & 7 days/week were routine**
- **Recognition of Need for After-Fielding Clean Up**
 - **Formalized needed leases and MOAs/MOUs**
 - **Minor safety adds to installed equipment**
 - **Long-term transition planning**



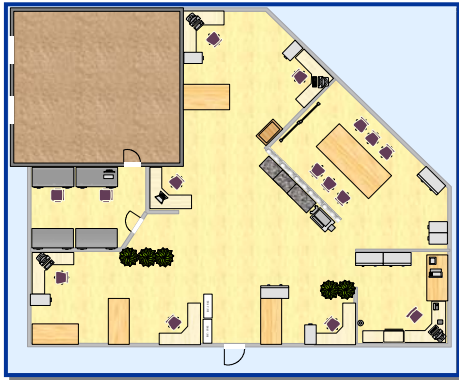
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 - ➔ ■ **Enablers to rapid development**
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- **Summary**



Enablers to Rapid Development

Facilities



Hardware / Software Enablers

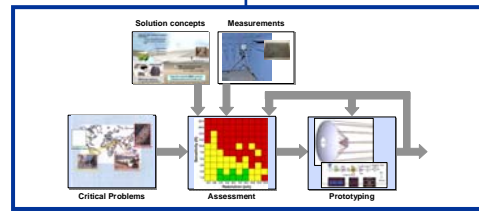


User Connection

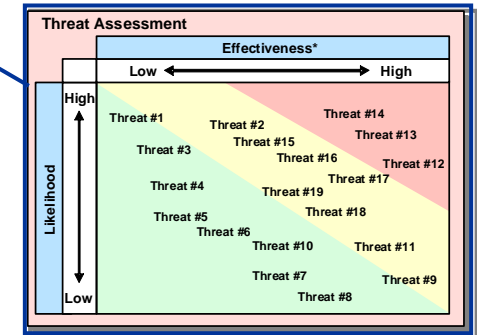


Rapid Innovation Cell

Blue Team Process



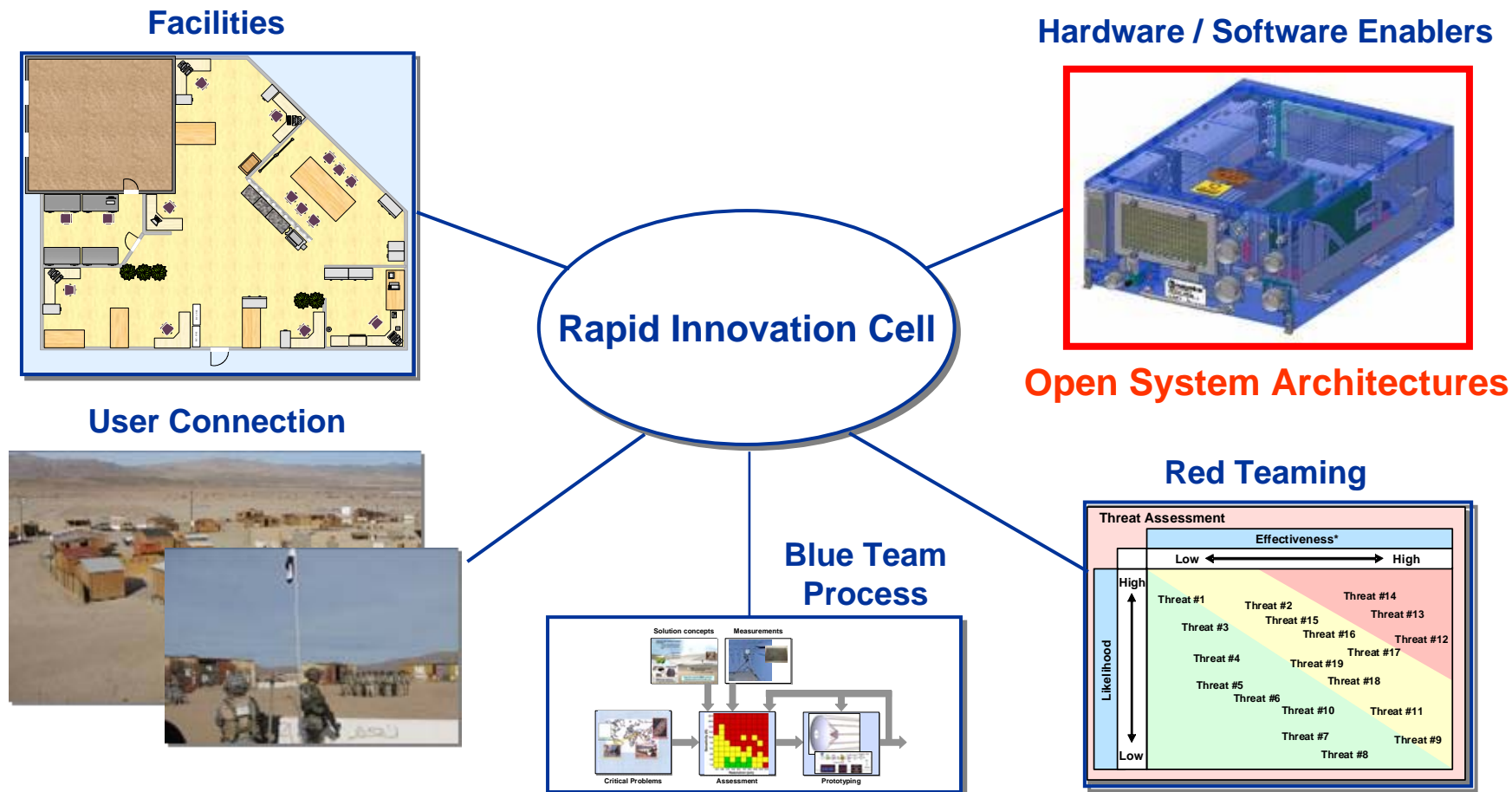
Red Teaming



- Series of elements key to enabling rapid innovation, demonstration, prototyping, and fielding of critical military capabilities



Enablers to Rapid Development



- Series of elements key to enabling rapid innovation, demonstration, prototyping, and fielding of critical military capabilities



Open System Architecture

Advantages

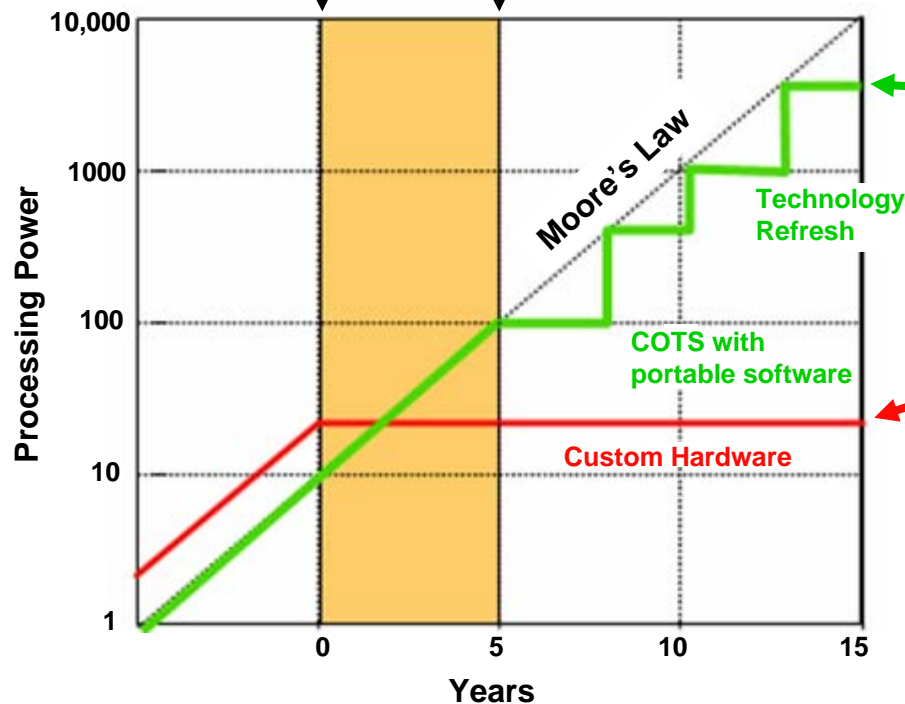
- ***Commonality allows lower cost ...***
 - Plug and play pieces reusable from system to system
- ***Innovation enabler ...***
 - Allows entrance of “smaller” players, often with innovative ideas
- ***Rapid development & rapid upgrades ...***
 - Open design allows replacement of individual components
 - Allows isolation of components that evolve technically at differing rates (e.g., rapid Moore’s Law advance in computing)
 - Upgrades vs. replace; more responsive to agile threats



Open Systems Support “Leverage Adapt” Strategy

Design freeze

Deployment



“Leverage & adapt”

- Good for rapidly changing technology
- Good for rapidly changing requirements
- Built-in refresh and improvements
- More difficult to manage

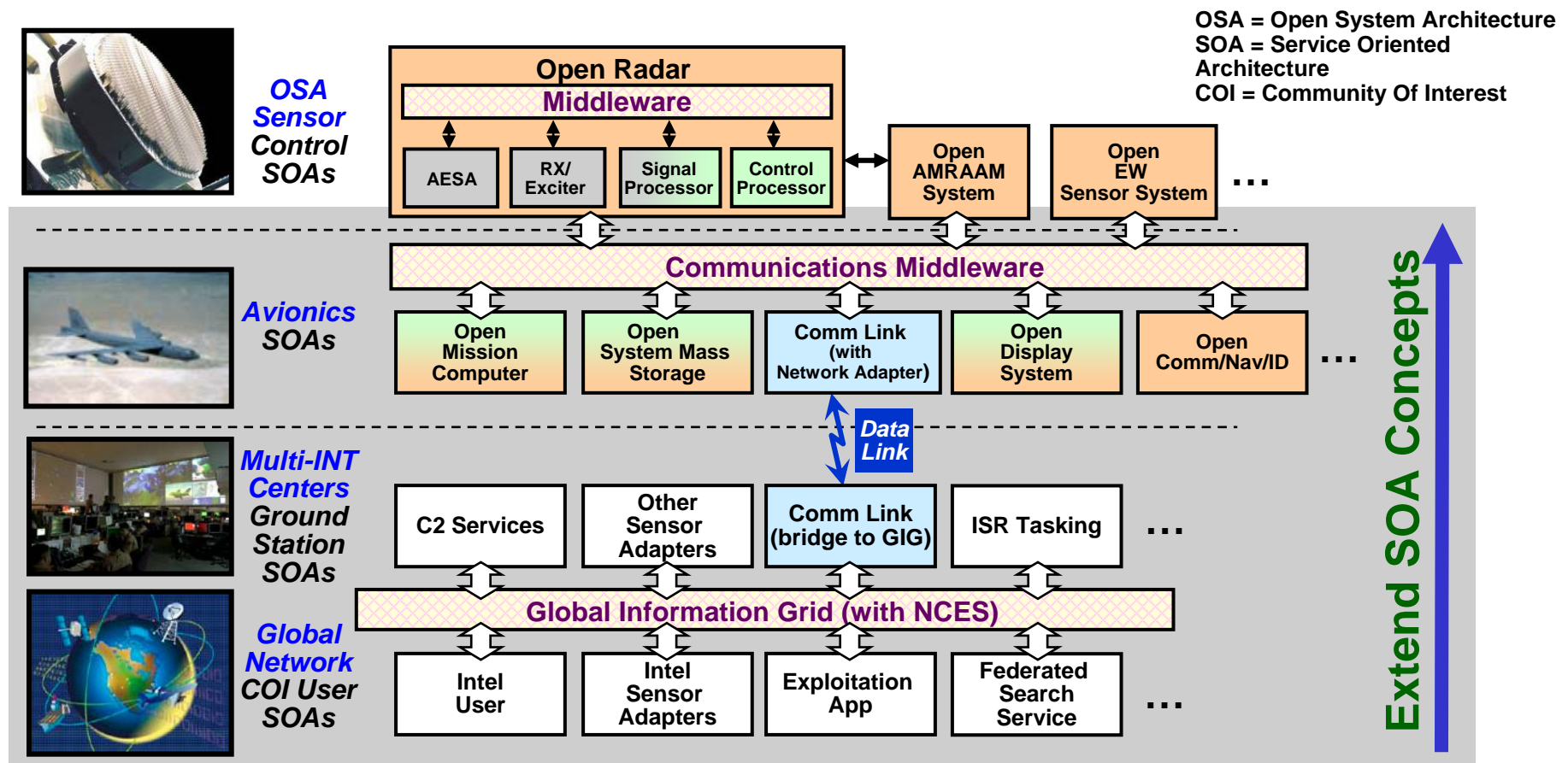
“Freeze & build”

- Freezes technology and builds to fixed design
- Acceptable for slow moving technologies
- Requires stable requirements throughout lifecycle
- Easier to manage with current acquisition strategy

- Open Systems supports “leverage and adapt” strategy; allows DoD to leverage commercial industry’s investment
- Continuous upgrade/refresh possible to meet evolving threats and obsolescence



Layered Open System Architecture Approach



- Change with technology and readily add new capabilities



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Prototyping Facilitates Innovation



“It is far easier for [users] to articulate what they want by playing with prototypes than by enumerating requirements.”[†]



[†] Schrage, Michael, *Serious Play: How the World's Best Companies Simulate to Innovate*, Harvard Business School Press, December 1999.

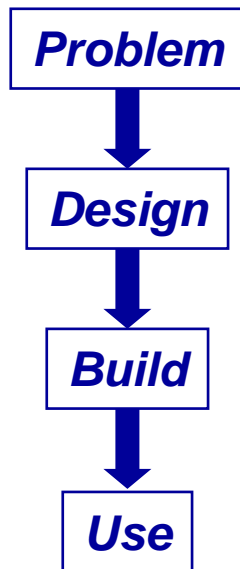
- Key additional use of rapid prototyping is for innovation; “simulate to innovate” concept



Development Approaches

Linear / “Waterfall” Approach

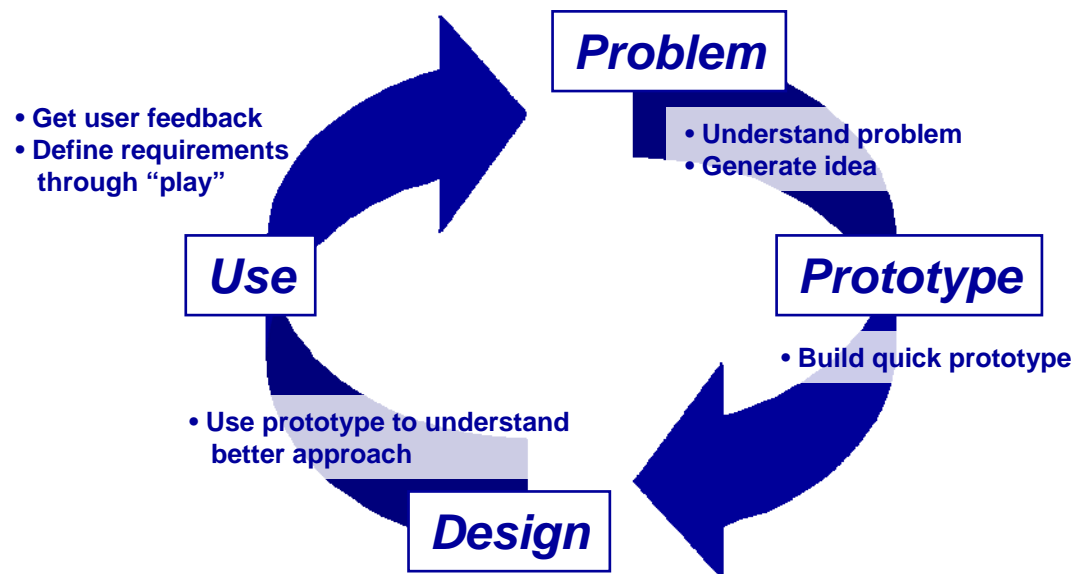
Fixed Design



- Assumes “design” can be accomplished apriori
- No developer / user co-design

Rapid Prototype Approach

Inherent Feedback



- Build prototypes to explore “design” approach
- Iterate based on user feedback; design influenced by user response



Prototype to Innovate

National Capital Region IADS



- Integrated Air Defense for protection of the National Capital Region

Touch Table



- Vehicle for novel data extraction / representation and action

X-37B Orbital Test Vehicle



- Unmanned reusable vehicle test platform for new space technologies



Summary

- **Rapid prototyping permits timely, cost effective military capability development**
 - **Strongly motivated by increasing pace of threat cycle**
- **Air Force Rapid Capabilities Office (SAF/RCO) established to expedite development of selected DoD systems**
 - **Number of successful projects (e.g., ERSA, NASAMS)**
- **Success of rapid developments dependent on variety of factors**
 - **80% solution mindset, strong team, enabling investments (e.g., Open system architectures)**
- **Additional rapid prototyping role in innovating new military capabilities**
 - **Rapid prototyping cycle allows refinement of solution**



Challenge to S&T Community

- Traditional “S&T Gap” still exists; greater warfighter interchange needed
- Apply rapid prototyping approach earlier in S&T development

Early insertion of new technologies
Faster innovation
Discovery of new / advanced capabilities

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